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Review

Effectiveness of online psychological and psychoeducational interventions to prevent depression: Systematic review and meta-analysis of randomized controlled trials

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ABSTRACT

Although evidence exists for the efficacy of interventions to prevent depression, little is known about its prevention through online interventions. We aim to assess the effectiveness of online psychological and psychoeducational interventions to prevent depression in heterogeneous populations. A systematic review and meta-analysis of randomized controlled trials (RCTs) was conducted based on literature searches in eight electronic data bases and other sources from inception to 22 July 2019. Of the 4181 abstracts reviewed, 501 were selected for full-text review, and 21 RCTs met the inclusion criteria, representing 10,134 participants from 11 countries and four continents. The pooled SMD was −0·26 (95%CI: −0·36 to −0·16; $p < 0.001$) and sensitivity analyses confirmed the robustness of this result. We did not find publication bias but there was substantial heterogeneity ($I^2 = 72\%$; 95%CI, 57% to 82%). A meta-regression including three variables explained 81% of the heterogeneity. Indicated prevention and interactive website delivery were statistically associated with higher effectiveness, and no association was observed with risk of bias. Online psychological and psychoeducational interventions have a small effect in reducing depressive symptoms in non-depressed and varied populations, and the quality of evidence is moderate. Given that these types of interventions are very accessible and can be applied on a wide scale, they should be further developed and implemented.

Registration details: Registration number (PROSPERO): CRD42014014804.

1. Introduction

Depression is a common, costly, and disabling mental disorder that reduces life expectancy (Parker, McCraw, Hadzi-Pavlovic, & Fletcher, 2013). Between 2007 and 2017, the depression burden, according to years lived with disability (YLDs), increased 14.1% and 14.8% for women and men, respectively (James et al., 2018). This means that, today, depression ranks third (women) and fifth (men) in global disease burden (James et al., 2018), and it is expected to be the first in developed countries by 2030 (Mathers & Loncar, 2006). One study (Chen, Kuhn, Prettner, & Bloom, 2018) calculated the cumulative macroeconomic burden projections for the US over the period 2015–2050 for the leading five non-communicable diseases (cardiovascular diseases, cancer, diabetes, chronic respiratory diseases and mental health conditions). These projections indicate that the costliest conditions are mental disorders and, among them, depressive disorders account for almost half

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of the global disease burden (Whiteford et al., 2013). In addition to their limited efficacy (Cuijpers, Cristea, Karyotaki, Reijnders, & Huibers, 2016), actual depression treatments display other limitations such as lack of adherence or reduced acceptability for users (Ho, Chong, Chaiyakunapruk, Tangiisuran, & Jacob, 2016; Linde et al., 2015). Assuming that it were possible to provide evidence-based treatments to all persons affected by a depressive disorder, due to the limited efficacy of actual treatments and to the steady incidence of depression, the reduction in YLD would be limited (Cuijpers, Beekman, & Reynolds, 2012). In this hypothetical context, it has been reported that depression burden can only be reduced by 30% (Chisholm, Sanderson, Ayuso, & Saxena, 2004). The prevention of depression – which avoids the development of the disease – emerges as a plausible approach to reducing disease burden.

Approaches to prevent the onset of depressive episodes have targeted people with prodromal symptoms not yet meeting the diagnostic criteria of a depressive disorder (indicated prevention), people at elevated risk because they have been exposed to risk factors (selective prevention), and the full population (universal prevention). The overall aim of the three types of preventive intervention —universal, selective, and indicated— is the reduction of the occurrence of new cases. Usually, this is done through a risk reduction model, and even though outcomes are in the distant future and the goal of fewer cases has not yet been established, the decrease in risk and/or increase in protective factors can be documented (Institute of Medicine (US) Committee on Prevention of Mental Disorders, Mrazek, & Haggerty, 1994), even including estimations of the individual probability of suffering depression in the future (Bellón et al., 2011). Depressive symptoms are a good predictor of future incidence of depression (Cuijpers & Smit, 2004), and their reduction can be seen as an indicator of decreased risk. Additionally, the aims of indicated preventive interventions might be to reduce the length of time the early symptoms continue and to halt a progression of severity so that the individuals do not meet, nor do they come close to meeting, DSM diagnostic levels (Mrazek, & Haggerty, 1994).

There is evidence of the effectiveness of psychological and educational interventions to prevent depression (Bellón et al., 2015; van Zoonen et al., 2014). Although the effect size is small (21% decrease in incidence in prevention groups in comparison with control groups), these relative numbers could be clinically relevant in absolute terms (avoided depression, increases in quality of life and cost reduction) if preventive interventions were scalable to a large number of people at risk. Accordingly, there is increasing agreement that prevention may reduce the incidence of new episodes of depression, YLDs, and their derived costs (Muñoz, Cuijpers, Smit, Barrera, & Leykin, 2010). In the EU Compass for Action on Mental Health and Well-being and the WHO Mental Health Action Plan 2013–2020, strategies and objectives were included for the prevention of depression (EU Compass, 2018; World Health Organization, 2013). In particular, online interventions to prevent depression have garnered increasing attention in the last decade (Ebert, Cuijpers, Muñoz, & Baumeister, 2017). The reasons for this interest lie in the advantages they offer compared to traditional interventions, such as greater intimacy, lower economic costs, the opportunity to access the intervention at any time and place, the ease of access to a wider range of people (disabled population, rural areas, etc.) and a reduction in waiting time (Andersson & Titov, 2014; Christensen & Griffiths, 2002).

Previous systematic reviews and meta-analyses (SR/MA) of online interventions in preventing depression have some limitations (Deady et al., 2017; Sander, Rausch, & Baumeister, 2016; Stratton et al., 2017; Zhou, Li, Pei, Gao, & Kong, 2016). They were focused on several mental disorders together (Sander et al., 2016) or on subthreshold depression (Zhou et al., 2016), included online interventions centred on specific online cognitive behavioural therapy (Zhou et al., 2016) or on employees (Stratton et al., 2017), children/adolescents or the elderly population, and publications in languages other than English were excluded (Deady et al., 2017); and included some studies combining depressed and not depressed patients at baseline (Stratton et al., 2017) or only reported mean scores and did not clearly state that participants did not exceed clinical cut-offs at baseline (Sander et al., 2016). Moreover, new RCTs on online interventions for the prevention of depression have been published (Batterham et al., 2017; Buntrock et al., 2016; Christensen et al., 2016; Cook, Mostazir, & Watkins, 2019; Ebert et al., 2018; Fonseca, Monteiro, Alves, Gorayeb, & Canavarro, 2019; Gladstone et al., 2018; Hoorelbeke, Faelens, Behiels, & Koster, 2015; Imamura et al., 2018; Lorenz, Heim, Roetger, Birrer, & Maercker, 2019; Topper, Emmelkamp, Watkins, & Ehring, 2017; Whittaker et al., 2017). To resolve these limitations, we aim to conduct an SR/MA of RCTs assessing the effectiveness of online psychological and psychoeducational depression interventions in preventing depression in heterogeneous populations.

2. Methods

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting systematic reviews and meta-analysis (Moher, Liberati, Tetzlaff, & Altman, 2009). This study is registered with the International Prospective Register of Systematic Reviews (PROSPERO) (registration number: CRD42014014804), and the protocol has been published elsewhere (Rigabert et al., 2018).

2.1. Selection criteria

The rationale for our inclusion criteria was to have a broad and comprehensive assessment of psychological and psychoeducational online interventions to prevent depression in all types of populations. We selected RCTs because they are in theory the experimental designs with the least bias. To ensure selection of RCTs that evaluated prevention interventions (interventions that occur before the onset of a depressive disorder), we included only RCTs that excluded at baseline depressed participants or that provided separate results for non-depressed participants at baseline, by using a standardized interview (e.g., SCID), or validated self-reports with standard cut-off points (e.g., CES-D). If the RCTs included both groups of depressed and non-depressed people, only the non-depressed group was considered in our analyses. Participants were not restricted by age, sex or any other demographic characteristic. We focused on psychoeducational and psychological interventions. The former simply provide information about depression through lectures or fact sheets, whereas psychological interventions attempt to change how people think, their behaviours, and their learning skills by using a variety of strategies (e.g., cognitive behavioural or interpersonal therapy). RCTs or arms including pharmacological or physical therapies were excluded. The intervention had to be delivered entirely online [accessible website or messages (text and/or videos) sent via e-mail or to a mobile phone] including at least one online session. We excluded interventions that combined online and face-to-face sessions ('blended interventions'). The comparators allowed were "only assessments" or "no treatment", "usual care", "waiting list", or any type of active control (psychological or pill placebo). Outcomes (as primary or secondary) included the incidence of new cases of depression and/or the reduction of depressive symptoms measured by standardized interviews or validated symptom scales. No limits were imposed on study publication language or setting.

2.2. Search strategy

In this SR/MA, we searched eight electronic databases, including PubMed, PsycINFO, WOS, Scopus, Cochrane Central Register of Controlled Trials (CENTRAL), ClinicalTrials.gov, Australia New Zealand Clinical Trials Register (ANZCTR) and OpenGrey (System Information on Grey Literature in Europe) from inception to 22 July 2019. This search strategy was supplemented with hand searching of reference lists

of articles and other relevant reviews on this topic. In addition, experts in the field were contacted and asked to complete the list of selected publications. Two academic websites comprising electronic databases were also explored, "Beacon 2.0" (https://beacon.anu.edu.au) and "Psychotherapy, randomized controlled and comparative trials" (http://www.evidencebasedpsychotherapies.org/). Search strategies were developed using key words and text words related to prevention, depression, and online intervention. They were piloted in PubMed then adapted to the other databases (all searches are provided in Appendix A). Databases were searched separately by two reviewers (AR and DMR).

2.3. Data extraction process and management

After removing duplicate studies, all records were reviewed, and those that did not meet the inclusion criteria after reading their titles and abstracts were excluded. Studies selected as potentially relevant were reviewed in full text for further assessment. All discrepancies were resolved by consensus with a third study reviewer (PMP). The inter-agreement of the total selection between reviewers was excellent (Fleiss, 1974) (Cohen K = 0·85; 95% CI, 0·49 to 1·00).

2.4. Risk of bias in individual studies

The quality of the articles was assessed using the six criteria for risk of bias proposed by the Cochrane Collaboration tool, version 1 (Higgins & Green, 2011). From a qualitative perspective, studies that scored low for risk of bias in specific domains (generation of the sequence, allocation concealment, blinding of evaluators of outcomes, and incomplete outcome data) were considered to have a low overall risk of bias. Excluded from this criterion were the items 'blinding of participants and personnel' because the nature of psychological and psychoeducational interventions makes them difficult to blind, and the item 'selective reporting' because in this meta-analysis we were only interested in the reduction of incidence of depression and/or depressive symptoms. In addition, to manage the risk of bias as a quantitative variable in the meta-regressions, each of the six items of the Cochrane Collaboration tool was scored as 2="high risk of bias", 1="unclear risk of bias" and 0="low risk of bias". Therefore, the highest risk of bias score was 12 and the lowest zero. Those studies that scored $\leq$3 points were considered to have a low overall risk of bias from a quantitative perspective. The risk of bias was assessed independently by two reviewers (AR and DMR). In the event of disagreement, a third reviewer (SCC) was consulted. There was excellent agreement between the two reviewers (the intraclass correlation coefficient was 0·84; 95% CI, 0·78 to 0·89).

3. Statistical analisis

3.1. Data analysis and calculation of effect size

Data extracted from each study were recorded in an evidence table and extracted by two independent reviewers (AR and DMR), whilst differences were resolved by consensus between them. We used the standardized mean difference (SMD) as the effect size because all RCTs included in our meta-analysis assessed differences in depressive symptoms, although some RCTs also assessed depression using standardized interviews. For each study, we calculated the SMD by combining the SMD at different post-test follow-up times into a single estimate as the average, as well as its 95% confidence interval (CI). Cohen proposed the following interpretation for this effect size: 0·2 is small; 0·5 medium and, 0·8 large (Cohen, 1989). Negative SMDs indicated an improvement in the reduction of depressive symptoms in the intervention group. When only depressive symptoms were reported, Comprehensive Meta-Analysis (version 3.0, Biostat Inc.) was used to obtain the equivalent odds ratios (OR) and their respective preventive fractions (1 minus OR) as a measure of the impact on health. We selected the random effects model under the assumption that the studies included in the meta-analysis were performed in a variety of populations that may differ from each other (Borenstein, Hedges, Higgins, & Rothstein, 2009).

3.2. Testing homogeneity

Statistical heterogeneity was calculated using the I^2 statistic (Higgins, Thompson, Deeks, & Altman, 2003), where a value of 0% to 40% indicates no important heterogeneity, 30% to 60% moderate, 50% to 90% substantial; and 75% to 100% can be interpreted as considerable (Higgins & Green, 2011). We also calculated the Q statistic and its *P* value.

3.3. Publication bias

Publication bias was evaluated by inspecting the funnel plot and using Duval and Tweedie's trim-and-fill procedure (Duval & Tweedie, 2000). We also performed Begg and Mazumdar (Begg & Mazumdar, 1994) rank correlation and Egger's test (Egger, Davey Smith, Schneider, & Minder, 1997).

3.4. Sensitivity analysis

We conducted sensitivity analyses at the first and last follow-up, using Hedges' g, excluding from analysis the RCT which caused the greatest increase in heterogeneity and including only RCTs with low overall risk of bias from both perspectives, qualitative and quantitative.

3.5. Quality of the evidence

We followed the Grading of Recommendations Assessment, Development and Evaluation (GRADE) working group methodology for assessing the quality of the evidence (Balshem et al., 2011). We considered the domains of risk of bias, consistency, directness, precision and publication bias.

3.6. Subgroup analyses

We used a mixed-effects model for a priori subgroup analyses according to country, age group, depression exclusion at baseline (symptoms scale versus standardized diagnostic interview), type of outcome (primary or secondary), outcome measure (symptoms scale versus standardized diagnostic interview), comparator, type of prevention (indicated, selective, or universal), number of sessions (intervention units delivered over time), presence of guidance, sample size, follow-up, and risk of bias.

3.7. Meta-regression

Meta-regression was performed to explain the between-trial heterogeneity observed. We verified the normality of the quantitative variables that were included in the meta-regression by the skewness-kurtosis normality test (D'Agostino, Belanger, & D'Agostino, 1990), undertaking the pertinent transformations to approximate normality when this was necessary. We forced the variable risk of bias in the meta-regression models for adjustment. The variable sample size was not forced because we did not find evidence of publication bias. Of the remaining co-variables considered for subgroup analysis, only one co-variable was introduced in each new model. The final model was composed of those co-variables with a significance level of $P < 0.15$ that were not removed from the model due to collinearity.

We used the Knapp and Hartung method (Knapp & Hartung, 2003) to estimate standard errors. Additionally, we used a Higgins and Thompson (Higgins & Thompson, 2004) permutation test approach to calculate *P* values, considering the adjustment for multiplicity (Monte Carlo approach; 20,000 permutations). A normal probability plot of

standardized shrunken residuals was used to estimate the goodness of fit of the final meta-regression model. We used Stata, version 14.2 (StataCorp) to perform analyses.

4. Results

4.1. Study selection

As a result of the search strategies, a total of 4181 articles were identified after eliminating duplicates. Of these, 501 articles were included for full-text review and 25 articles reporting outcomes for 21 different RCTs with 22 comparisons met the inclusion criteria of the meta-analysis (see Fig. 1).

4.2. Study characteristics

The characteristics of the 21 RCTs included are described in Table 1. The RCTs were conducted in Europe ($N = 10$) (Buntrock et al., 2015, 2016; Cook et al., 2019; Ebert et al., 2018; Fonseca et al., 2019; Hoorelbeke et al., 2015; Lintvedt et al., 2013; Lorenz et al., 2019; Musiat et al., 2014; Spek et al., 2007; Spek et al., 2008; Topper et al., 2017) the United States ($N = 5$) (Barrera, Wickham, & Muñoz, 2015; Clarke et al., 2002; Cukrowicz & Joiner Jr., 2007; Gladstone et al., 2018; Makarushka & Murray, 2011), Australia and New Zealand (N = 5) (Batterham et al., 2017; Calear, Christensen, Mackinnon, Griffiths, & O'Kearney, 2009; Christensen et al., 2016; Morgan, Jorm, & Mackinnon, 2012; Whittaker et al., 2017), and Japan ($N = 2$) (Imamura et al., 2015; Imamura et al., 2018, 2014). All were published between 2002 and 2019. Overall, the

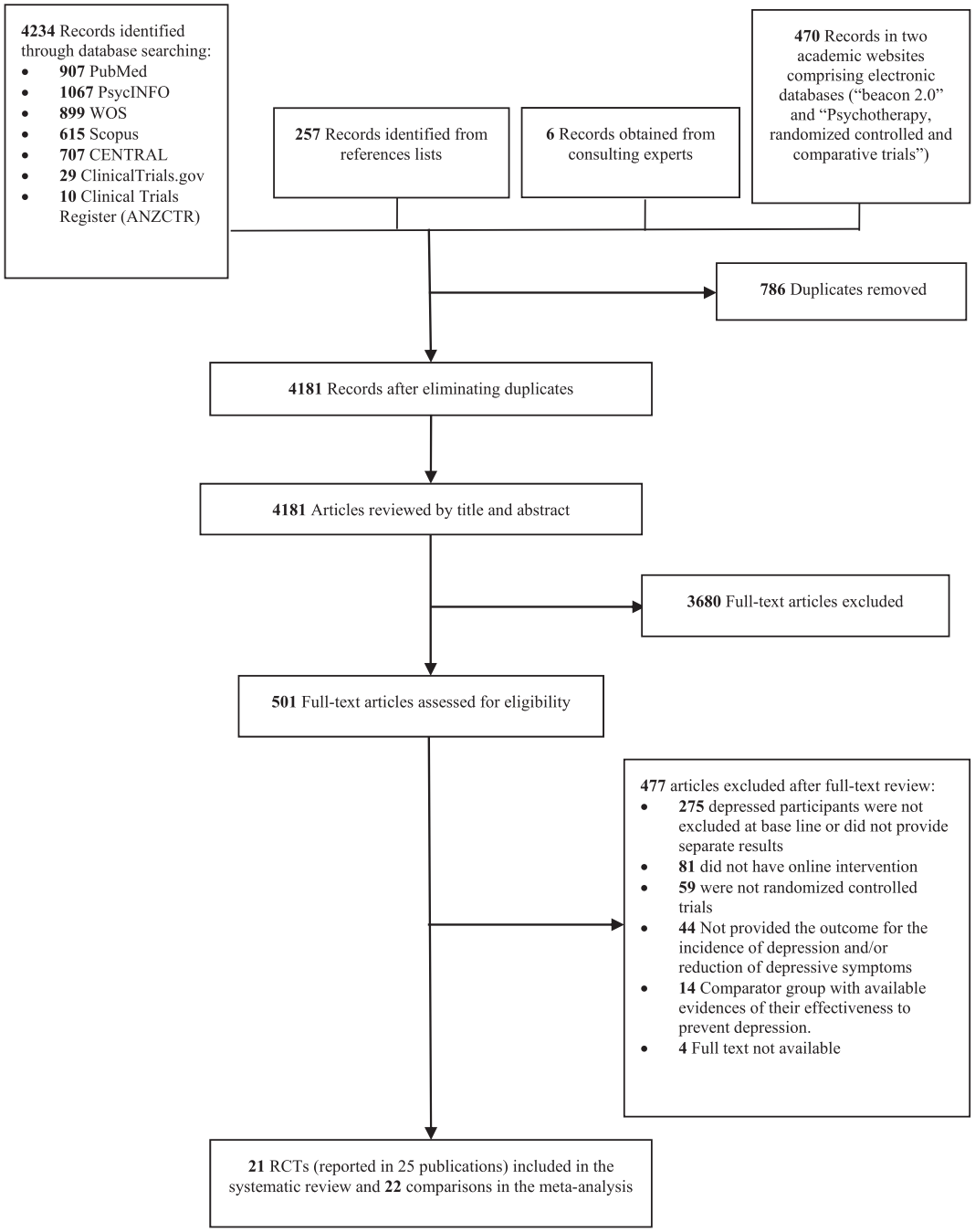


Fig. 1. PRISMA Flowchart of the Randomized Clinical Trials (RCTs) included.

Table 1
Characteristics of the randomized controlled trials included.

Author/year Country	Target population/ type prevention	Exclusion criteria for baseline depression	Inclusion criteria related to depression or anxiety	Sample (control / intervention)	Conditions	Intervention orientation (Number of sessions; Format)	Guidance	Primary outcome	Evaluations during follow-up
Barrera et al., 2015 EEUU	Pregnant women/ Indicated	MDD (MDE Screener)	There was no inclusion criteria related to depression	852 (417/435)	1.e-MB 2. Active control	CBT based (8; website)	Unguided	Depressive symptoms (CES-D) and onset of MDD (MDE Screener)	26 weeks
Buntrock et al., 2015 & Buntrock et al., 2016 Germany	Adults (≥18 years)/ Indicated	MDD (SCID)	CES-D ≥ 16 Not currently receiving psychotherapy or in the past 6 months. BDI item 9 score > 1.	406 (204/202)	1. GET.ON Mood Enhancer Prevention 2. Active control	CBT based, psychoeducation, and problem-solving techniques (6; website)	Guided	Depressive symptoms (CES-D) and onset of MDD (SCID)	26 and 52 weeks
Calear et al., 2009 Australia	Adolescents/ Universal	CES-D ≥ 24	RCMAS <19	1477 (914/563)	1. MoodGYM 2. Waiting list	CBT based and interpersonal therapy (5; website)	Guided	Depressive symptoms (CES-D)	26 weeks
Christensen et al., 2016 & Batterham et al., 2017Australia	Community dwelling adults aged 18–64/ Indicated	MDD (MINI)	CES-D: ≥ 4 to ≤20 No suicidal plans (MINI)	1149 (575/ 574)	1. SHUTi 2. Active control	CBT based, sleep restriction, stimulus control, sleep hygiene, and relapse prevention (6; website)	Unguided	Depressive symptoms (PHQ-9)	26, 52 and 78 weeks
Clarke et al., 2002 EEUU	Adults (≥18 years)/ Indicated	CES-D > 20	There was no inclusion criteria related to depression	76 (39/37) [a]	1.ODIN 2. Usual care	CBT based (7; website)	Unguided	Depressive symptoms (CES-D)	4, 8, 16 and, 32 weeks
Cook et al., 2019 UK	University students/ Selective	MDD (SCID)	PHQ-8 < 15	235 (77/82/76)[b]	1.Guided i-RFCBT 2.Unguided i-RFCBT 3. Waiting list	CBT based (6; website)	Guided & unguided	Depressive symptoms (PHQ-9)	13, 26 and 65 weeks
Cukrowicz & Joiner Jr., 2007 EEUU	University students/ Selective	BDI > 19	BAI: ≤ 18; BDI: ≤ 19	152 (71/81)	1.CBASP 2.Active control	CBT based (6; website)	Guided	Depressive symptoms (BDI)	8 weeks
Ebert et al., 2018 Germany	Adults (≥18 years)/ Indicated	MDD (SCID)	CES-D ≥ 16 Not currently receiving psychotherapy or in the past 6 months. BDI item 9 score > 1	204 (102/102)	1. GET.ON Mood Enhancer 2. Waiting list	CBT based, psycho-education, and problem-solving techniques (6; website)	Guided	Depressive symptoms (CES-D)	7 and 13 weeks
Fonseca et al., 2019 Portugal	Women in early postpartum period (>3 months postpartum)/ Selective	EPDS≥9	PDPI-*R* ≥ 5.5 and/or EPDS <9	70 (23/47) [c]	1.Be a Mom 2.Waiting list	CBT based (5; website)	Unguided	Depressive symptoms (EPDS)	8 weeks
Gladstone et al., 2018 EEUU	Adolescents (13–18 years) in primary care/Indicated	Current MDD diagnosis (K-SADS) CES-D > 17	CES-D: ≥8 to ≤17 and/or a past history of depression or dysthymia	369 (176/193)	1.CATCH-IT 2. Active control	CB Humanistic and Interpersonal (15 adolescent modules and 5 parents modules, supported by three motivational interviews; website and face to face)	Guided	Onset of MDD (DSR ≥3 obtained from KLIFE and K-SADS) Depressive symptoms (CES-D)	8 and 26 weeks
Hoorelbeke et al., 2017 Belgium	Adults (≥18 years)/ Indicated	MDD (MINI)	History of depression showing stable remission (≥ 6 months) (MINI)	68 (34/34)[d]	1. CCT 2. Active control	CCT (10; website)	Unguided	Depressive symptoms (BDI-II)	2 and 12 weeks
Imamura et al., 2014 & Imamura et al., 2015 Japan	Workers in private companies in Japan/ Universal	MDD (WHO-CIDI 3.0.)	Not receiving medical treatment for mental health problems during past month	762 (381/381)	1. iCBT 2. Active control	CBT based and problem-solving skills (6; website)	Guided	Depressive symptoms (BDI-II)	12, 26 and 52 weeks
Imamura et al., 2018 Japan	Workers in private companies in Japan/ Universal	MDD (WHO-CIDI 3.0.).	There was no inclusion criteria related to depression	667 (335/332)	1. iCBT 2. Active control	CBT based and problem-solving skills (6; website)	Guided	Depressive symptoms (BDI-II)	12, 26 and 52 weeks

(*continued on next page*)

Table 1 (*continued*)

Author/year Country	Target population/ type prevention	Exclusion criteria for baseline depression	Inclusion criteria related to depression or anxiety	Sample (control / intervention)	Conditions	Intervention orientation (Number of sessions; Format)	Guidance	Primary outcome	Evaluations during follow-up
Lintvedt et al., 2013 Norway	University students/ Selective	CES-D ≥ 16	K10 ≥ 20	39 (14/25)[e]	1. MoodGYM and BluePages 2. Waiting list	CBT based and interpersonal therapy (5; website)	Unguided	Depressive symptoms (CES-D)	8 weeks
Lorenz et al., 2019 Germany	Adults (≥18 years)/ Indicated	BDI-II ≥ 19	There was no inclusion criteria related to depression	56 (27/29)	1.CBT-I 2.Waiting list	CBT based, psycho-education, sleep restriction, relaxation, sleep hygiene, cognitive restructuring and changing sleep-related behaviours (6; website)	Unguided (Virtual sleep coach)	Depressive symptoms (BDI-II)	6 weeks
Makarushka & Murray, 2011 EEUU	Adolescents (11–15 years)/Indicated	MDD (WHO-CIDI 3.0)	CES-D ≥ 16	239 (117/122)	1. CWD-A 2. Active control	CBT based (6; website)	Guided	Depressive symptoms (CES-D)	6 and 26 weeks
Morgan et al., 2012 Australia	Adults (≥18 years)/ Indicated	PHQ-9 ≥ 8	PHQ-9 ≥ 4 and ≤ 8 Not receiving treatment for depression from a health professional	1326 (661/665)	1. Mood Memos 2.Active control	CBT based (12; e-mails)	Unguided	Depressive symptoms (PHQ-9)	3 and 6 weeks
Musiat et al., 2014 UK	University students (≥18 years/) /Selective	PHQ-9 ≥ 10	There was no inclusion criteria related to depression[c]	761 (380/381)[f]	1.PLUS 2.Active control	CBT based (5; website)	Unguided	Depressive symptoms (PHQ-9)	6 and 12 weeks
Spek et al., 2007 & Spek et al., 2008 Netherland	Adults (50–75 years)/ Indicated	MDD (CIDI-WHO, 1997).	EDS ≥ 12	202 (102/100)[g]	1. CWD 2. Waiting list.	CBT based (8; website)	Unguided	Depression symptoms (BDI-II)	10, 26 and 52 weeks
Topper et al., 2017 Netherland	Adolescents/ Universal	PHQ-9 ≥ 10	≥ 75th percentile on one PSWQ or RRS and ≥ 66th percentile on PSWQ or RRS	169 (85/84)[h]	1.Internet modified version of RFCBT 2. Waiting list	CBT based (6; website)	Guided	Depression symptoms (BDI-II)	13 and 52 weeks
Whittaker et al., 2017 New-Zealand	Adolescents/ Selective	CDRS-*R* ≤ 65 CDRS-R item 13 < 5 RADS-2 < 76 and low score on four out of the six critical items and low risk of self-harm (item 14)		855 (429/426)	1.MEMO CBT 2.Active control	CBT based (15; mobile messages)	Unguided	Depressive symptoms (CDRS-R)	9 and 52 weeks

MDD: Major depressive disorder; MDE Screener: Major Depressive Episode Screener; CES-D: Centre for Epidemiologic Studies of Depression; SCID: Structured Clinical Interview for DSM; BDI: Beck Depression Inventory; PDPI-R: Postpartum Depression Predictors Inventory-Revised; RCMAS: Revised Children's Manifest Anxiety Scale; MINI: Mini International Neuropsychiatric Interview; MADRS-S: Montgomery-Äsberg Depression Rating Scale; CIDI-WHO: Composite International Diagnostic Interview; K10: Kessler Psychological Distress Scale; PHQ-9: Patient health questionnaire; QIDS: Quick Inventory of Depressive Symptomatology-Clinician Rating 16-item; EDS: Edinburgh Depression Scale; PSWQ: Penn State Worry Questionnaire; RRS: Ruminative Response Scale; CDRS-R: Child Depression Rating Scale-Revised; RADS-2: Reynolds adolescent depression scale-second edition; DSR: Depression Severity Rating; K-SADS: The Kiddie Schedule for Affective Disorders Scale; BAI: Beck Anxiety Inventory; KLIFE: Kiddie Longitudinal Interval Follow-up Evaluation.
e-MB: Mothers and babies internet course; GET.ON Mood Enhancer Prevention: based on elements from behaviour therapy and problem-solving therapy self-help intervention; MoodGYM: online cognitive-behavioural program that is fully automated and self-directed; SHUTi: Sleep Healthy Using The internet; ODIN: Overcoming Depression on the Internet; CBASP: Cognitive-Behavioural Analysis System of Psychotherapy; CCT: Cognitive Control Training; iCBT: Internet-Based Cognitive Behavioural Therapy; BluePages: provides evidence-based information about depression; CBT-I: Cognitive behavioural therapy for insomnia; CWD-A: Coping with depression course Adolescents; Mood Memos: self-help strategies; PLUS: Personality and Living of University Students; CWD: Coping with depression course; RFCBT: Rumination-focused CBT; MEMO CBT: universal cognitive behavioural therapy-based programme; CBT: Cognitive Behavioural Therapy; CATCH-IT: Competent Adulthood Transition with Cognitive Behavioural Humanistic and Interpersonal Training.

[a] Only subclinical sample included. Total sample of 299 (155/144).
[b] This trial had three arm groups, control group, guided intervention and unguided intervention.
[c] Only subclinical sample included. Total sample of 194(96/98).
[d] Only subclinical sample included. Total sample of 163 (82/81).
[e] Contacted the lead author of the study for subclinical sample.
[f] Only subclinical sample included. Total sample of 1047(528/519).
[g] This trial had a third arm, group intervention, which was not considered in our study since did not offer online intervention.
[h] This trial had a third arm, face to face CBT, which was not considered in our study since did not offer online intervention.

21 RCTs evaluated a total of 10,134 participants, 4971 in the intervention group and 5163 in the control group. Sample sizes ranged from 39 to 1477 (median = 222; IQR 152 to 772). Regarding the target population, twelve RCTs were aimed at the adult population, five targeted adolescents, four university students. The average of mean ages for 20 RCTs was 31.8 years (SD = 12.6).

All online interventions were psychological and/or psychoeducational, based on the principle of Cognitive Behavioural Therapy (CBT), complemented using interpersonal therapy in three RCTs, and problem-solving techniques in three further RCTs. Depression at baseline was excluded by structured-standardized interviews in eleven RCTs and by symptoms scales in the rest. All RCTs had as the primary outcome reduction of depressive symptoms or incidence of depression. In 18 RCTs the reduction of depressive symptoms was the primary outcome. Moreover, in three RCTs the incidence of depression was also measured, one using the Structured Clinical Interview for DSM-IV (SCID), one using the Major Depression Episode Screener, and one using the Depression Severity Rating and the Kiddie Schedule for Affective Disorders Scale. The comparator was active control in 12 RCTs. Ten RCTs provided guidance to the participants. In 19, the online intervention was delivered providing a web-link; in 18 of these, it was left to the initiative of the participants to visit the study's Internet site and in one, the implementation of the program was undertaken using school computers. In one RCT, the intervention was delivered via weekly emails; and one RCT sent daily videos and text messages via mobile phone. Follow-up periods ranged from 6 to 96 weeks (median = 28 weeks; IQR 12 to 48 weeks). Indicated, selective, and universal prevention were evaluated in eleven, six, and three RCTs, respectively.

4.3. Study risk of bias

The risk of bias for each study is reported in Table 2. From the qualitative criteria, eight RCTs had a low overall risk of bias and only six RCTs had low risk of bias in blinding of participants and personnel. From the quantitative criteria (range 0–12 points), ten RCTs had less than 3 points and one had 3 points, six RCTs had a risk of 4–5 points, and another four had a risk of 6 points.

4.4. Primary and sensitivity analysis

Meta-analysis calculations were based on 22 comparisons performed in 21 RCTs (Fig. 2). The pooled SMD was −0.26 (95% CI, −0.36 to −0.16, $P < 0.001$) for the random model, and this indicates that online psychological and educational interventions had a small and statistically significant effect on the reduction of depressive symptoms in non-depressed people. The pooled SMDs revealed that the effect sizes decreased slightly over time. At the first evaluation, the SMD was −0.30 (−0.42 to −0.18), and at the last evaluation it had decreased to −0.23 (−0.34 to −0.13). The equivalent pooled OR was 0.63 (95% CI, 0.52 to 0.75, P < 0.001), which would mean a theoretical reduction in the incidence of depression (preventive fraction) of 37%. There was substantial heterogeneity across the studies (I^2 = 72%; 95% CI: 57% to 82%), and this was statistically significant (Q = 74.53; d.f. = 21; P < 0.001). The primary analysis changed very little in the sensitivity analyses, although there was tendency towards increased effectiveness in the RCTs with low overall risk of bias (see Table 3).

4.5. Publication bias

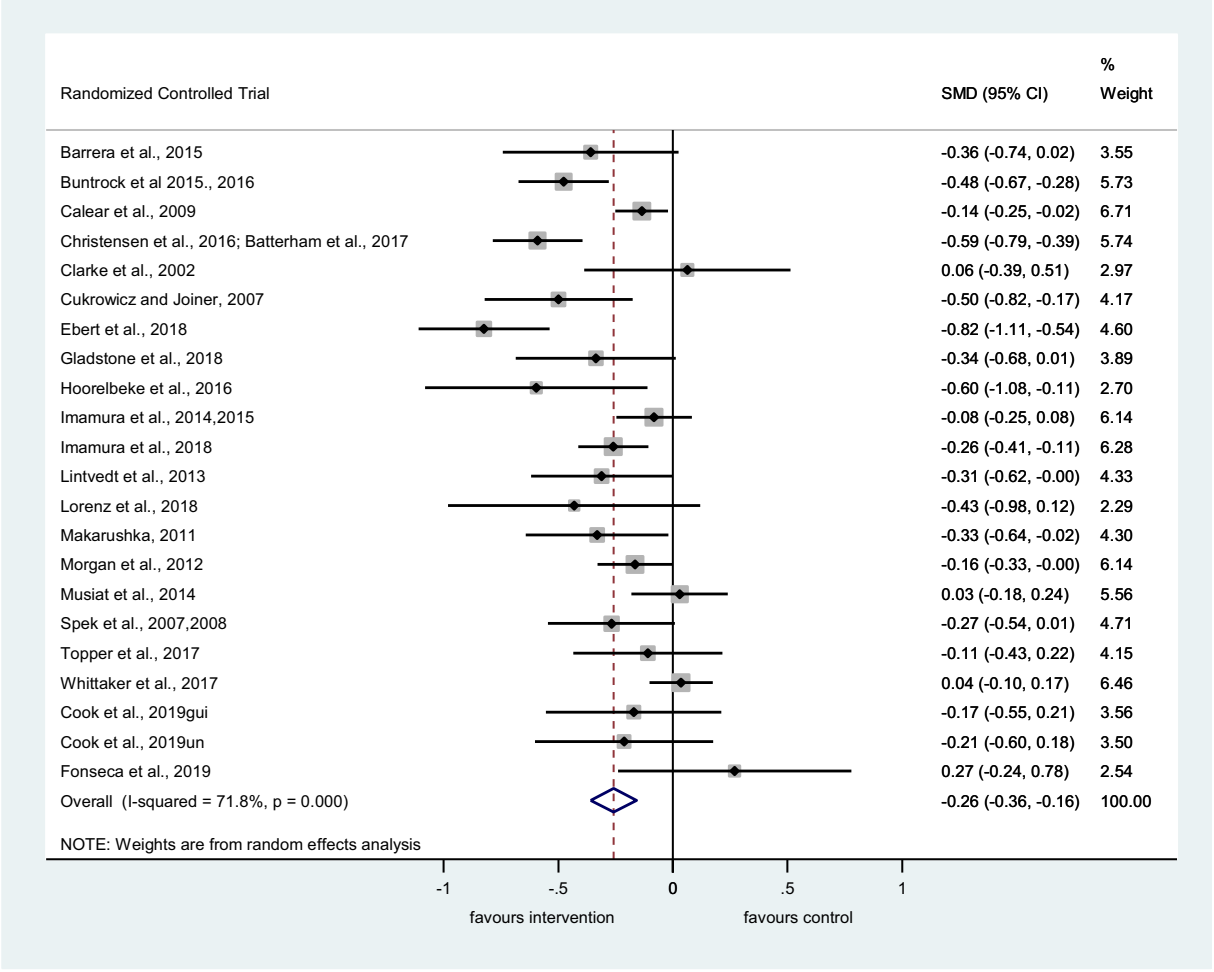
The Egger (bias, −1.28; 95% CI, −3.22 to 0.66; $P = 0.185$) and Begg and Mazumdar (z = 0.73; $P = 0.463$) tests to detect publication bias were not statistically significant. Duval and Tweedie's procedure did not impute any missing RCT, and the funnel plot had a symmetrical appearance (see Appendix B).

4.6. Subgroup analysis

Table 4 shows the subgroup analyses. The effectiveness was higher in the USA and Europe, in adults, when standardized diagnostic interviews were used for excluding depression at baseline and as an outcome

Table 2
Risk of bias ($N = 21$ Randomized Controlled Trials).

	Selection bias		Performance bias	Detection bias	Attrition bias	Reporting bias	Score
	Random sequence Generation (0–3)	Allocation concealment(0–3)	Blinding of participants and personnel (0–3)	Blinding of Outcome assessment (0–3)	Incomplete outcome data (0–3)	Selective Reporting (0–3)	Range (0−12)
Barrera et al., 2015	Low (0)	Unclear (1)	High (2)	Unclear (1)	Unclear (1)	Unclear (1)	6
Buntrock et al., 2015, 2016	Low (0)	Low (0)	Low(0)	Low(0)	Low(0)	Low(0)	0
Calear et al., 2009	Low (0)	Low (0)	High (2)	High (2)	Low(0)	Low(0)	4
Christensen et al., 2016 & Batterham et al., 2017	Low (0)	Low (0)	Low(0)	Low(0)	Low(0)	Low(0)	0
Cook et al., 2019	Low (0)	Low (0)	High (2)	Low (0)	Low (0)	Low (0)	2
Clarke et al., 2002	Low (0)	Unclear (1)	Unclear(1)	Unclear(1)	Unclear(1)	Unclear (1)	5
Cukrowicz and Joiner, 2007	Unclear (1)	Unclear (1)	Unclear (1)	High (2)	Low(0)	Unclear (1)	6
Ebert et al., 2018	Low (0)	Low (0)	Unclear (1)	Low(0)	Low(0)	Low (0)	1
Fonseca et al., 2019	Low (0)	Low (0)	High (2)	Low (0)	Unclear(1)	Unclear (1)	4
Gladstone et al., 2018	Low (0)	Low (0)	High (2)	Low(0)	Low(0)	Low(0)	2
Hoorelbeke et al., 2017	Low (0)	Low (0)	Low(0)	Low(0)	Low(0)	Unclear(1)	1
Imamura et al., 2014 & Imamura et al., 2015	Unclear (1)	Low (0)	High (2)	Low(0)	High (2)	Low(0)	5
Imamura et al., 2018	Low (0)	Low (0)	Unclear (1)	Low (0)	Unclear (1)	Low (0)	2
Lorenz et al., 2019	Low (0)	Low (0)	High (2)	Low (0)	Low (0)	Low (0)	2
Lintvedt et al., 2013	Low (0)	Unclear(1)	Unclear (1)	Unclear(1)	High (2)	Low (0)	5
Makarushka & Murray, 2011	Unclear (1)	Unclear (1)	Unclear(1)	Unclear(1)	High (2)	Low(0)	6
Morgan et al., 2012	Unclear (1)	Unclear (1)	Low(0)	Unclear(1)	Low(0)	Low(0)	3
Musiat et al., 2014	Low (0)	Low (0)	Low(0)	Low (0)	Low (0)	Unclear (1)	1
Spek et al., 2007, 2008	Unclear (1)	Unclear (1)	Unclear (1)	High (2)	Low (0)	Low(0)	5
Topper et al., 2017	High (2)	Low (0)	High (2)	Unclear(1)	Low (0)	Unclear(1)	6
Whittaker et al., 2017	Low (0)	Low (0)	Low (0)	Unclear (1)	Low (0)	Unclear (1)	2
Average risk	0.33	0.33	1.10	0.62	0.48	0.38	3.4



SMD: Standardized Mean Differences

Fig. 2. Forest Plot. SMD: Standardized Mean Differences.

measure, in indicated prevention, and for interventions with interactive website delivery and five or six sessions. The effectiveness was not associated with follow-up time.

4.7. Meta-regression

Meta-regression is reported in Table 5. The final meta-regression model including three moderators explained 81% of the heterogeneity and its goodness of fit was good (see Appendix C). Indicated prevention and interactive website delivery were statistically associated with higher effectiveness, although the latter was no longer significant when it was adjusted for the multiple comparisons. The risk of bias did not reach statistical significance.

4.8. Quality of evidence

The initial grading of the quality of the evidence was high a priori since we included only RCTs. We reduced the rating from high to moderate because the heterogeneity was substantial, although 81% of that was explained by the meta-regression. Indirectness was low since the target population; the interventions and our outcome did not differ from those of primary interest. There was no statistical evidence of publication bias. We included a sufficient number of studies, and the total number of participants in our study allowed adequate precision. Approximately half of the included RCTs (between 8 and 11 according to qualitative or quantitative criteria) had low overall risk of bias and for these there was a tendency to slightly increase the effectiveness to prevent depression. In summary, the quality of evidence according to GRADE was moderate.

5. Discussion

5.1. Main findings

We found that online psychosocial and educational depression interventions were effective in reducing depressive symptoms in non-depressed people. All these interventions were based mainly on CBT principles. The overall effect size was small but statistically significant, and sensitivity analyses demonstrated that this result is robust. We did not find publication bias, and the quality of the evidence was moderate. These findings were derived from 21 RCTs which included 10,134 participants from 11 countries on four continents. Heterogeneity was substantial and most explained by a meta-regression model including three variables, two of which had a statistically significant association with higher effectiveness (indicated prevention and interactive website delivery), whilst risk of bias did not.

5.2. Strengths

To the best of our knowledge, this is the first SR/MA to examine the

Table 3
Effectiveness of psychosocial and educational online interventions to prevent depression (N = 21 RCTs with 22 comparisons).

Effectiveness to prevent depression	Number of comparisons	SMD (95% C.I.)	P Value	I^2 (95% C.I.)
Primary analysis	22	−0.26 (−0.36 to −0.16)	<0.001	72% (57% to 82%)
Sensitivity analyses				
At first evaluation	22	−0.30 (−0.42 to −0.18)	<0.001	81% (73% to 87%)
At last evaluation	22	−0.23 (−0.34 to −0.13)	<0.001	72% (58% to 82%)
Fixed-effects model	22	−0.21 (−0.26 to −0.17)	<0.001	72% (57% to 82%)
Hedges' g	22	−0.26 (−0.36 to −0.16)	<0.001	72% (58% to 83%)
[a]Whittaker et al., 2017 excluded	21	−0.28 (−0.38 to −0.18)	<0.001	65% (45% to 78%)
[b] Including only RCT with low risk of bias	9	−0.35 (−0.56 to −0.13)	0.001	85% (73% to 91%)
[c] Including only RCT with low risk of bias	12	−0.32 (−0.48 to −0.16)	<0.001	81% (69% to 89%)

RCTs: randomized clinical trials; SMD: Standardized Mean Difference.
[a] The RCT that most increased heterogeneity.
[b] Qualitative criteria for inclusion (RCTs that scored low risk of bias in the generation of the sequence, allocation concealment, blinding of evaluators of outcomes and incomplete outcome data): Buntrock et al., *2015* / 2016; Christensen et al., *2016* & Batterham et al., *2017*; Ebert et al., *2018*; Gladstone et al., *2018*; Hoorelbeke et al., 2016; Lorenz et al., 2019; Musiat et al., *2014*; Cook et al., *2019* guided; Cook et al., *2019* unguided.
[c] Quantitative criteria for inclusion (RCTs that scored ≤ 3 points, score range 0–12): Buntrock et al., *2015* / 2016; Christensen et al., *2016* & Batterham et al., *2017*; Ebert et al., *2018*; Gladstone et al., *2018*; Hoorelbeke et al., 2016; Imamura et al., *2018*; Lorenz et al., 2019; Morgan et al., *2012*; Musiat et al., *2014*; Whittaker et al., *2017*; Cook et al., *2019* guided; Cook et al., *2019* unguided.

effectiveness of online psychological and psychoeducational interventions for the reduction of depressive symptoms in non-depressed people. Our meta-analysis included a reasonable number of RCTs representing a large population of individuals with different characteristics and from different settings. These aspects give the study a wide scope, which supports its external validity. We used multiple complementary electronic databases with supplementary hand searching. Thus, the variety of databases utilized, combined with the broad range of search terms and no restriction on study publication language, contributed to a highly sensitive search. In addition, the strict inclusion criteria, analysing only RCTs with a study population free of depression at baseline, allowed us to clearly distinguish prevention from treatment effectiveness. Study selection, data extraction, and risk of bias assessment were performed by trained and independent reviewers, with good interobserver reliability. We applied rigorous methodology (PRISMA, GRADE) to the SR/MA process and evaluation of the quality of the evidence. We also performed sensitivity analyses, which support the robustness of the pooled SMDs in different setups (analyses and evaluation times) or when only RCTs with low risk of bias were included. Finally, subgroup analyses allowed identification of possible sources of heterogeneity, and the meta-regression model explained most of this and enabled adjustment for confounding biases and multiple comparisons.

5.3. Limitations

There are several limitations should be considered when interpreting these results. First, in most of the RCTs the psychological and psychoeducational components were mixed, making it difficult to separate them. None of the online interventions had a predominant social component, and most of the interventions were CBT oriented. Therefore, the inferences can only be applied to the intervention profile found in our meta-analysis. Further RCTs with other types of online psychological (e.g. mindfulness, interpersonal or acceptance and commitment therapy) (Donker et al., 2013) and/or psychosocial orientations (e.g., via social networking sites or moderated online social therapy) (Ridout & Campbell, 2018) are needed. Second, the external validity of our study seems relevant; however, all RCTs included were conducted in high-income countries, and thus the inferences should again be limited. Moreover, older people, probably due to their technology gap, were under-represented in our meta-analysis. Further adaptation of online interventions for minorities and non-Western settings are needed (Barrera et al., 2015; Van Voorhees et al., 2011). Third, only nine RCTs had more than 40 weeks of follow-up and three had 60 or more weeks. Therefore, although there was no statistical significance at follow-up time, firm conclusions about long-term effectiveness cannot be drawn from our study. Fourth, as we mentioned previously in the Introduction, the reduction of depressive symptoms in non-depressed people is also included in the conceptual framework of depression prevention (Mrazek & Haggerty, 1994); however the endpoint of preventive interventions is the reduction of the occurrence of new cases of depression and few trials of our SR/MA addressed this outcome; therefore, further RCTs that assess the incidence of new cases of depression through standardized diagnostic interviews are also needed. Fifth, in our meta-analysis we did not include any studies focused on the prevention of the first episode of depression; consequently, we were unable to provide results on the effectiveness of online interventions for the prevention of first-episode depression. Finally, in some categories of specific subgroup analysis, the number of RCTs was low; in these cases (e.g., delivery format by e-mails or mobile messages), the lack of statistical power prevents firm conclusions.

5.4. Comparison with the previous research

In our study there was a tendency towards increased effectiveness in adults; however, adjustment for confounding bias in meta-regression eliminated any statistical significance. Online interventions would likely be more effective when properly adapted to people of different ages (children, adolescents, adults and elderly) (Ebert et al., 2017). We also found a tendency towards greater effectiveness in those studies using a standardized diagnostic interview to rule out depression at baseline and/or as an outcome; although adjustment again eliminated any statistical significance. Standardized diagnostic interviews generally have greater validity than symptom scales; nevertheless, the reduction of depression symptoms is also useful as an outcome because in addition to the improvement in health it has a positive and relevant effect on quality of life and cost (Lynch et al., 2005). In our meta-analysis, we did not find differences in effectiveness for prevention of depression according the guidance of the online interventions. It has been suggested that guided versus unguided online interventions would have greater adherence and effectiveness for treatment of depression (Baumeister, Reichler, Munzinger, & Lin, 2014; Paganini, Teigelkötter, Buntrock, & Baumeister, 2018; Richards & Richardson, 2012); but there is also evidence of no difference for people with diagnosed depression (Königbauer, Letsch, Doebler, Ebert, & Baumeister, 2017). Unfortunately, the systematic review and meta-analyses only included studies for treatment and not for prevention of depression. RCTs comparing guided and unguided online interventions to prevent depression (Weisel et al., 2019) and also comparing human and automated support are needed (Mira et al., 2017).

The overall effect size obtained in our study was small. The same

Table 4
Subgroup analyses.

Subgroup analyses	N	SMD[a]	95% CI	P^b	I^2	Between-group Heterogeneity [c]
Country						
USA	5	−0.328	−0.486 to −0.169	<0.001	0%	Q = 7.72; d.f.(Q) = 2; $p = 0.021$
Europe	11	−0.288	−0.468 to −0.109	0.002	71%	
Australia-Asia	6	−0.191	−0.340 to 0.042	0.012	83%	
Age						
Adolescents	5	−0.128	−0.261 to 0.005	0.060	50%	Q = 15.27; d.f.(Q) = 2; $p < 0.001$
University population	5	−0.215	−0.416 to 0.014	0.036	52%	
Adults	12	−0.323	−0.472 to −0.175	<0.001	74%	
Depression exclusion at baseline						
Symptom scale	10	−0.114	−0.222 to −0.006	0.039	49%	Q = 24.80; d.f.(Q) = 1; $p < 0.001$
Standardized diagnostic interview	12	−0.370	−0.500 to −0.240	<0.001	67%	
Outcome measure						
Symptom scale	21	0.244	−0.346 to −0.143	<0.001	70%	Q = 7.22; d.f.(Q) = 1; $p = 0.007$
Standardized diagnostic interview	1	0.476	−0.674 to −0.279	<0.001	n.a.	
Comparator						
Usual Care	3	0.123	−0.356 to 0.110	0.300	0%	Q = 0.63; d.f.(Q) = 2; $p = 0.730$
Waiting List	7	−0.273	−0.494 to −0.052	0.015	75%	
Active Control	12	−0.275	−0.408 to −0.141	<0.001	78%	
Type of prevention						
Universal	3	−0.158	−0.253 to −0.064	0.001	25%	Q = 30.73; d.f.(Q) = 2;
Selective	8	−0.116	−0.265 to 0.033	0.127	53%	$p < 0.001$
Indicated	11	−0.399	−0.542 to −0.256	<0.001	62%	
Delivery format						
E-mails[d] or mobile[e] messages	2	−0.059	−0.255 to 0.137	0.556	70%	Q = 12.24; d.f.(Q) = 1; $p < 0.001$
Interactive website	18	−0.286	−0.392 to −0.180	<0.001	68%	
Guidance						
Unguided	12	−0.206	−0.360 to −0.052	0.009	72%	Q = 2.94; d.f.(Q) = 1; $p = 0.086$
Guided	10	−0.310	−0.445 to −0.175	<0.001	72%	
Number of sessions						
5–6	15	−0.284	−0.409 to −0.158	<0.001	74%	Q = 6.88; d.f.(Q) = 1; $p = 0.009$
>6	7	−0.187	−0.343 to −0.031	0.019	56%	
Sample size						
≤200	9	−0.233	−0.392 to −0.074	0.004	31%	Q = 4.63; d.f.(Q) = 2; $p = 0.099$
201–855	9	−0.309	−0.467 to −0.151	<0.001	75%	
>1000	4	−0.205	−0.426 to 0.017	0.070	89%	
Risk of bias (qualitative criteria)						
Low[f]	9	−0.399	−0.598 to −0.200	<0.001	75%	Q = 20.92; d.f.(Q) = 1;
Moderate/High	13	−0.164	−0.250 to −0.079	<0.001	45%	$p < 0.001$
Risk of bias (quantitative criteria, range 0–12)						
Low (scored 0–3)	12	−0.315	−0.475 to −0.155	<0.001	81%	Q = 6.73; d.f.(Q) = 2; $p = 0.035$
Moderate (scored 4–5)	6	−0.129	−0.225 to −0.033	0.009	12%	
High (scored 6)	4	−0.322	−0.489 to −0.156	<0.001	0%	
Follow up						
1–20 weeks	8	−0.314	−0.547 to −0.082	<0.001	78%	Q = 1.71; d.f.(Q) = 2; $p = 0.425$
21–40 weeks	4	−0.171	−0.292 to −0.049	0.006	9%	
>40 weeks	10	−0.247	−0.392 to −0.102	0.001	76%	

d.f.: degree of freedom; n.a.: not applicable.
[a] SMD: standardized mean difference.
[b] Significance tests in which for each subgroup the null hypothesis is that SMD = 0.
[c] Q values represent the comparison of subgroup means based on a chi-square distribution in which the null hypothesis is that the effect size is the same for all subgroups.
[d] e-mails sent twice a week.
[e] text messages and videos sent daily to the mobile phone.
[f] studies that scored low risk of bias in generation of the sequence, allocation concealment, blinding of evaluators of outcomes, and incomplete outcome data.

occurs with other SR/MA that analyzed the effectiveness of psychological interventions (Bellon et al., 2015; van Zoonen et al., 2014) to prevent the onset of depression, and specific psychological online interventions to prevent depression (Deady et al., 2017; Stratton et al., 2017; Zhou et al., 2016). However, the previous SR/MA that examined online interventions have some limitations. For example, they focused on a specific population (Deady et al., 2017; Stratton et al., 2017) or a specific intervention (Zhou et al., 2016), or they did not exclude depressed patients at baseline (Sander et al., 2016; Stratton et al., 2017). In general, and in relative terms, as a preventive fraction, the effectiveness of both online and face-to-face psychological interventions is small (20–30% of incidence reduction).

However, if they were massively implemented and this were cost-effective, the overall impact in absolute terms could be substantial resulting in dramatic improvements in public health outcomes such as mental health, quality of life, burden of disease, and cost.

5.5. Practical implications

Three strategies to implement interventions on a large scale to prevent depression have been suggested: in schools (Werner-Seidler, Perry, Calear, Newby, & Christensen, 2017), primary care (Bellón et al., 2016; Conejo-Cerón et al., 2017; Fernández et al., 2018), and the workplace (Bellón et al., 2019). All three have advantages if they include the target population for depression prevention programs, that is, the population without clinical depression and with different levels of risk. All three would also depend on different facilitators: teachers, nurses and general practitioners, and company staff, respectively. Internet interventions at large have been around for about 20 years (Andersson, 2018). Mental health apps offer the potential to overcome access barriers for the nearly

Table 5
Meta-regression.

Final Model[a]	β (95% CI)[b]	P Value	P Value (95% CI)[c]
Indicated Prevention	−0.2431 (−0.4053 to −0.0809)	0.006	0.0187 (0.0168 to 0.0206)
Interactive Website Delivery	−0.2323 (−0.4382 to −0.0317)	0.026	0.0746 (0.0710 to 0.0783)
Risk of bias (sqrt)[d]	0.0715 (−0.0361 to 0.1791)	0.180	0.4033 (0.3964 to 0.4101)

[a] Model $F_{3,18} = 7.42$; P = 0.0019; I^2 residual = 35.07%; Adjusted R^2 = 81.10%.
[b] Knapp and Hartung method for estimation of Standard Error and 95% Confidence Intervals (CI).
[c] Higgins and Thompson permutation test to calculate P values considering multiplicity adjustment (Monte Carlo approach with 20,000 permutations).
[d] Square root transformation.

three billion people projected to own a smartphone by 2020 (Torous et al., 2019), and provide novel ways to motivate healthy behaviours such as automated tailoring, real-time engagement, gamification and intrinsic motivation to engage, log of past app use, reminders to engage, or simple and intuitive interface and interactions (Bakker, Kazantzis, Rickwood, & Rickard, 2016). Online interventions are also very flexible and adaptable, as participants are able to adjust them and manage them freely, as they are accessible through different devices (mobile phones, computers, tablets, etc.), and participation can be completed at any individual speed.

Nowadays one limitation of online depression prevention interventions is poor adherence as this can contribute to reduce their effectiveness (Calear, Christensen, Mackinnon, Kathleen, & Griffiths, 2013; Kelders, Bohlmeijer, & Van Gemert-Pijnen, 2013; Ramphos, Kelman, Stanley, & Barrera, 2019). In our meta-analysis, we found that more interactive online interventions were more effective than more passive ones (Morgan et al., 2012), even if they were delivered with attractive messages and videos (Whittaker et al., 2017). Another limitation concerns digital literacy (especially in older people), safety and privacy, ethical issues, and data integration with electronic health records (Torous et al., 2019). In addition, the potential harm of these interventions is not well understood (Ebert et al., 2017). New technological elements potentially applicable to online interventions to prevent depression are being developed: use of sensors through smartphones (Boonstra et al., 2018), virtual and augmented reality (Quero et al., 2019), machine learning and artificial intelligence (Briffault, Morgiève, & Courtet, 2018; Fulmer, Joerin, Gentile, Lakerink, & Rauws, 2018). Unfortunately, RCTs on their effectiveness in preventing depression are not yet available.

Recently, a meta-analysis found that guided online psychological interventions for the indicated prevention of depression (subthreshold depression) have the potential to be cost-effective (Paganini et al., 2018); however, this conclusion cannot be extended to selective and universal online prevention of depression, and the comparative cost-effectiveness of guided versus unguided intervention has not yet been studied (Weisel et al., 2019). The economic case for preventing mental illness and promoting better mental health may be very strong, but too often, prevention attracts little attention and few resources (McDaid, Park, & Wahlbeck, 2019).

6. Conclusion

In conclusion, we found that online psychological and psychoeducational interventions are effective in reducing depressive symptoms in non-depressed people, with a moderate quality of evidence. Given that these types of interventions are very accessible and can be administered on a wide scale, they should be further developed and implemented.

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Contributors

ARS, JAB, and EM designed the study and the other authors collaborated on the design. ARS, JAB, EM, DMR, SCC, PC, CMG, and YD acquired, analyzed and interpreted the data.

ARS, JAB, and EM drafted the manuscript and DMR, SCC, PC, CMG, and YD conducted a critical revision of the manuscript for important intellectual content. All authors discussed and approved the final version. ARS and JAB are the guarantors.

Ethics

As this systematic review and meta-analysis is based on published data, approval from the local ethics committee was not required.

So far, Juan Bellón has published about 100 scientific articles, 37 of them in Q1 (of which 12 in D1), 15 in Q2 and 11 in Q3 with an h index of 22. He is main author of 31 articles, of which 19 are in D1 or Q1. He got an internship at the University College of London for 6-months and he shares authorship with researchers from other countries in 24 articles. In the last ten years, he has supervised 7 Doctoral Theses.

He has obtained competitive public funding for international (3), national (22) and autonomous (19) research projects, and he has been a principal researcher in 26 of them. He is part of the intensification program of the research activity in ISCIII-Ministry of Health and Junta de Andalucía from 2005 to the present. He has achieved a research funding of € 5,471,866 to date. He has been evaluator of 27 journals of the JCR (20 in Q1, of which 11 are in D1) and he has received 17 research awards (2 international, 11 national and 4 regional). He has been the research coordinator of the Spanish Society of Family and Community Medicine for 4 years and one of the members who developed the different research plans of the Junta de Andalucía.

Declaration of Competing Interest

The authors all declare they have no competing interests. The funders had no direct role in the design or conduct of the study, interpretation of the data, or review of the manuscript.

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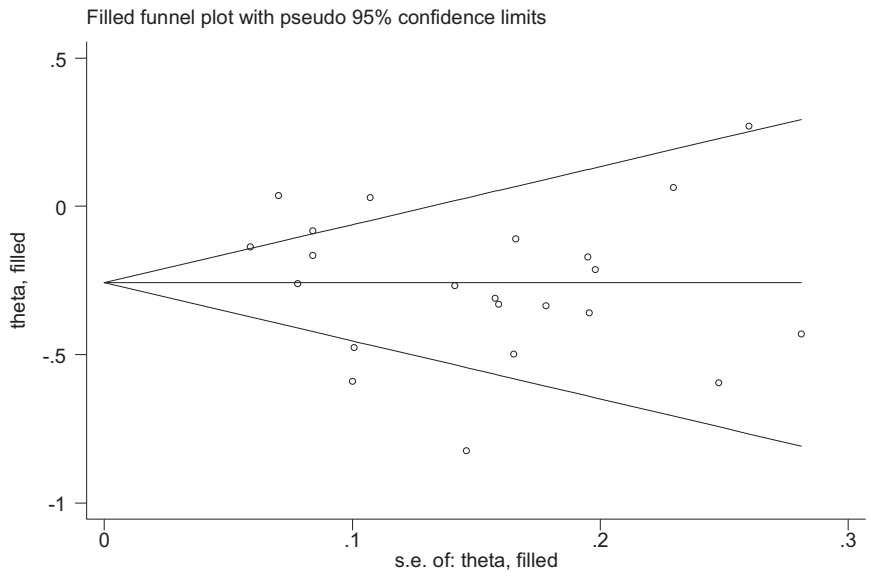

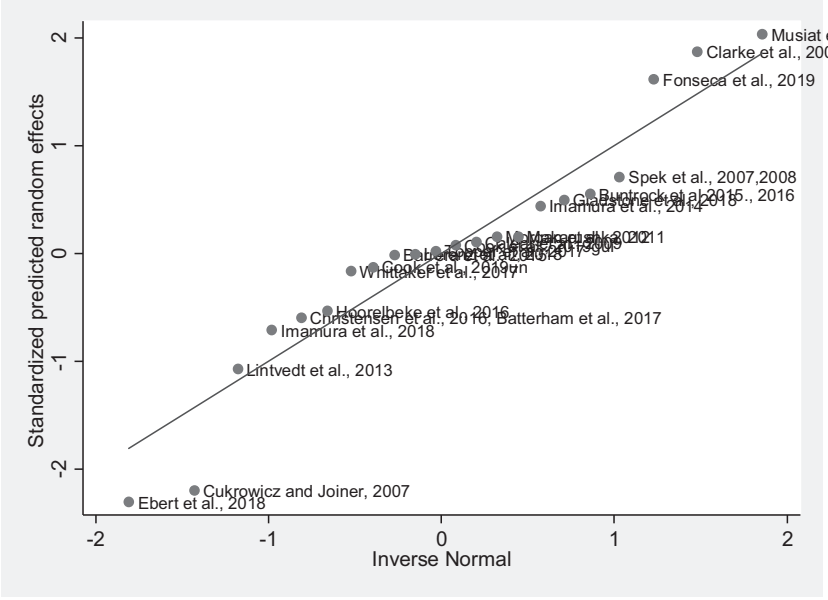

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